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The Neurological Evaluation of Children with Learning Disorders

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FROM A CLINICAL POINT OF VIEW, the term *learning disorder* means that there is good evidence that a child's learning performance at school is not commensurate with his intellectual abilities. Children with such problems are being brought to to physicians in increasing numbers for assistance in the identification of factors contributing to poor classroom performance. Parents and teachers expect the physician to be able to help them unravel the difficult issues of distinguishing between neurological handicaps, behavioral disturbances and faulty educational procedures as causes for school learning problems. These distinctions are often difficult, for all three of these factors are commonly found to have contributed to an educational problem. The physician who accepts the role of neurological consultant should regard a learning disorder as a symptom, the cause of which is his responsibility to elaborate to the fullest possible extent.[1]

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A recent review of various studies of reading disorders in the United States has resulted in an estimate that 15 percent of school age children are affected by learning disorders[2]; other estimates have ranged from 5 to 30 percent. In addition, it is clear that these children are not uniformly distributed throughout the country and that prevalence is largely determined by social and economic factors. No simple formula will serve to explain the nature of this pervasive problem. Many physicians are reluctant to become involved with the problem of learning disorders because of a sense of inadequacy to cope with the issues at hand. Others have become overly committed to some specific mode of treatment in which comprehensive consideration of the child's problem is avoided. The field of learning disorders is one that has been especially susceptible to extravagant claims by therapists of all types.

The physician serving as a neurological consultant has several roles in the evaluation of children with learning disorders. It is his responsibility to detect the presence of neurological conditions that may be present in these children. He is expected to be an expert authority on theories

relating brain dysfunction in children to learning problems. Finally, the neurological consultant is expected to point the way to appropriate treatment programs that will permit a child to achieve his full potential at school as well as at home.

The purpose of this review is to outline the role of the neurological consultant in the evaluation of children with learning disorders. This will be considered under the following headings: The Neurological Examination; Differential Diagnosis; Learning Disorder Syndromes.

The Neurological Examination

The actual neurological examination of the young school-age child is quite similar to the conventional neurological examination for adults. Essentially the same outline of procedures is utilized in spite of frequent implications that there are special methods used by the pediatric neurologist (this is true more for examinations of infants). The unique feature of the pediatric neurologic examination is the special attention given to evaluating developmental milestones and developmental disorders. The diagnosis formulated by the neurologist is often largely based upon obtaining a discriminating history of the child's progress in motor, language and social areas. The occurrence of possible brain-damaging events and pertinent family history will contribute to the final formulation. Occasionally, evidence of overt neurological deficits or of progressive neurological disorders will be recognized.

A few remarks are in order regarding interpretation of the neurological examination in children. Certain signs can be regarded as indicative of neurological disease regardless of age or state. For example, the presence of spasticity, dystonia, muscle wasting or muscle fasciculations can be regarded as abnormal at any age. A fully developed extensor plantar response can be accepted as an abnormal sign after the first two years of life. However, there are many aspects of the neurological examination, particularly in the evaluation of of proprioceptive functions, that are difficult to interpret in the elementary school child. It is particularly important to keep in mind that motivation and mental state will greatly influence the ability of a child to perform complex motor acts. An important guideline for the examiner is to distinguish between loss of previously acquired abilities and the failure of acquisition of abilities. Much of the traditional neurological examination of complex motor functions is based upon demonstration of loss of abilities of well defined deviations from the norm. These criteria are often not fulfilled in the diagnosis of "borderline" neurological abnormalities claimed to be present in children with learning disorders. There are virtually no normative data meeting ordinary standards of reliability regarding acquisition of abilities such as the performance of rapid pronation-supination of the hands, performance of tandem walking, the behavior of outstretched hands, the occurrence of overflow movements, and other "soft" neurological signs. When normative data are available, as in the establishment of laterality functions,[4] there is often evidence of wide variations in the timetable of acquisition.

It is an important responsibility of the neurological consultant to distinguish between hard evidence of neurological abnormality and the hazier "soft" neurological signs. In general, he is best advised not to allow suspicion of these latter signs to justify a diagnosis of brain dysfunction, minimal or otherwise.

The examination of an elementary school child should be approached circumspectly. It is best to engage the child at the outset in a conversation about a familiar subject—asking his age, grade and name of his teacher may be a good beginning. This can lead into questions regarding his favorite television program, names of friends, favorite games and relationships with siblings. Pencil and paper tests and brief reading tests can be administered at this time. After a relationship has been established, the child may be more inclined to disrobe for the neurological examination.

The following is an outline of the historical data that should be obtained and the examinations that should be carried out:

Historical data

Pregnancy history

Perinatal history—Mode of delivery, complications, birth weight, estimate of maturity, condition at birth, neonatal problems.

Developmental milestones—Data on motor and language development. Age at walking unsupported seems to be the most reliable milestone elicited retrospectively.[5]

Developmental disorders—Indications of speech disturbances, and data on delayed speech, poor speech comprehensions, hearing difficulties, delay in establishment of hand preference beyond two to three years of age, early over-activity, enuresis, pica, sleepwalking, temper tantrums, breathhold-

ing spells, physical awkwardness in motor tasks or games.

Medical history—Head injuries associated with loss of consciousness, meningitis or encephalitis, recurrent ear infections, visual disorders, medication history, intoxications.

Family history—Educational history of parents and siblings, of family psychiatric disturbances, and of neurological disorders in family.

School history—Performance in earlier grades and nursery school. When did learning problem in school begin?

Present status—School grade placement, behavior at home and at school, peer and family relationships, physical complaints (headaches, abdominal pains, ocular problems). Present medications. Other evaluations.

General Examination

Height, weight and head circumference—These should be plotted on growth curves.

General inspection—Unusual cranial configurations. Inspection of skin for cutaneous abnormalities such as *cafe-au-lait* spots, or vascular nevi. Appearance of the genitalia. General nutritional status.

Mental status—Affect, ability to relate, and fund of information for age. Note activity level, distractibility, evidence of autistic behavior or other signs of a thought disorder.

Speech—Evidence of dysarthric, dysrhythmic or aphasic speech patterns.

Cranial nerves—Visual acuity, evidence of strabismus, smoothness of visual pursuit, presence of facial asymmetries. (These items of especial importance.) Note presence of nystagmus or poor tongue control.

Motor functions—Evaluate muscle strength and tone in all four extremities. Overt paresis will usually be associated with reduced muscle mass and abnormalities of muscle tone. An extremity that has been dysfunctional since infancy due to central nervous system abnormalities will be shorter than its opposite mate. If asymmetries are suspected the circumference and length of extremities should be measured with a tape measure.

Lesser diminution of muscle strength may not be associated with obvious disturbances of tone or strength but may be the cause of coordination difficulties. It is important to distinguish coordination problems due to weakness from those due to ataxia. A clue as to the nature of the problem may come from the assessment of muscle tone and reflexes. Ataxia is often associated with hypotonia whereas weakness of cerebral origin is associated with hyperreflexia and often, although not invariably, abnormal increase of muscle tone. Children with ataxia do not manifest any evidence of diminished strength when muscle strength is evaluated independently of coordinative abilities.

The assessment of muscle tone is one of the most important aspects of the neurological examination of children. The responses of large muscle groups to both fast and slow stretching is evaluated. Spasticity refers to the presence of a hyperactive stretch reflex; stretching of the muscle sets into action a reflex shortening of the muscle fibers. This reflex resistance to stretching is evident at the beginning of the stretch but then disappears, resulting in the "clasp-knife" type of increased muscle tone. It is particularly evident in the antigravity muscles—for example, the extensors of the leg and flexors of the arm. Rigidity refers to a constant increased resistance to muscle stretching, sometimes in the form of intermittent resistance known as "cogwheeling." Rigidity is traditionally associated with extrapyramidal disease states that may also produce movement disorders.

Hand preference can be determined by questioning a parent and noting hand used in writing and throwing. Foot preference can be evaluated by asking a child to kick a ball. This information is of little significance, however, aside from its use in detecting a hemiparetic condition.

Gait should be observed, with attention to evidence of abnormal gaits suggestive of cerebral palsy syndromes. Also to be noted is the ability to run and rapidly reverse direction, and ability to walk on toes and heels. It should be remembered that a child's gait is especially sensitive to a feeling of self-consciousness when under observation.

Coordinative skills can be assessed by ability to handle buttons and shoelaces or catch a ball. The presence of ataxia or incoordination of voluntary movements is additionally evaluated by performance of finger to nose movements with the hands outstretched, performance of tandem walking, hopping on either foot and rapid supination-pronation movements of hands on knees.

Involuntary movements — Involuntary movements can be noted by observing a child in a stationary state with hands resting lightly on knees or outstretched in front. Sometimes involuntary movements are better noted while engaging a child in conversation that is mildly stressful. Some chil-

dren will attempt to inhibit these movements by holding one hand with another or shifting in the chair. The examiner should release the hands and place them separately on the child's knees when involuntary movements are being sought. Choreic movements are rapid, brief, irregular muscular jerks of the face or extremities. Athetoid movements refer to slower, twisting movements often imposed upon voluntary movements, causing unnatural posturing. Tics are stereotyped muscle twitching involving the same muscle groups repetitively, often affecting facial or ocular muscles.

Overflow or associated movements are a type of involuntary movement occurring in one area of the body when a voluntary movement is initiated in another area—for example, finger tapping or touching of thumb to forefinger. Mirror movements are a type of overflow phenomenon in which the associated movement occurs on the opposite side. These movements have been regarded as abnormal after the age of nine years[6,7] but much depends upon the particular movement elicited. In general, published studies indicate a wide age range of acquisition of ability to inhibit overflow phenomena. Connolly and Stratton[8] utilized a number of specified movements for observation such as the movement of a contralateral thumb when pinching a clip, movement of arms upon walking on inverted feet, and several finger moving exercises. They reported a gradual disappearance of associated movements in ordinary school children up into the midteens. Each movement had its own timetable of disappearance. Inhibition of overflow is also a function of mental age; hence, mentally retarded children can be expected to manifest these movements more freely than children of normal intelligence.

Normally, mirror movements may be seen more readily in the dominant hand or leg. However, an unusually strong asymmetry of associated movements should alert the clinician to the possibility of hemiparesis on the side not displaying the mirror movements.

Reflexes—The presence of decidedly asymmetrical deep tendon reflexes is more significant than symmetrical variation of reflex activity. It may indicate the presence of hemiparesis. The presence of clonus upon eliciting lower extremity deep tendon reflexes or upon firmly dorsiflexing the foot should be noted. Ankle or knee clonus is always abnormal in school age children.

Twitchell et al[9] described a posturing of the outstretched hands in which the hands assume a position of overpronation with flexion of wrists and extension of fingers. This is termed the "avoiding response" and has been regarded as persistence of an infantile reflex, indicating the presence of "minimal cerebral dysfunction."

Tests of Body Awareness and Right-Left Orientation

Two-point discriminations. The ability to distinguish between double simultaneous somasthetic stimulation is a standard procedure in attempting to detect parietal lobe dysfunction in adults. The closer together the points of stimulation, the more sensitive the test. Discrimination of simultaneous stimulation of two fingers of one hand is said to be possible for over 95 percent of children more than seven years of age.[10] Similar discrimination between face and hand stimulation is said to be possible for normal children over six years of age.[11]

Tests of sensory discrimination utilizing double simultaneous stimulation have not been extensively employed due to the difficulty of establishing reliability of the procedure (the work of Kinsbourne and Warrington is an exception). Nevertheless, tests of this sort offer considerable theoretical advantages in the investigation of global perceptual abilities because motor performance is not an integral part of the test procedure.

Right-left discriminations—The ability to indicate the right and left parts of the child's body is usually present by seven years of age[4,12,13] although the range in normal children extends up to ten years. The ability to perform double crossed tasks (for example, "Touch your left ear with your right hand") and to recognize the examiner's body parts ("Touch my right knee with your left hand") develops later and in a more variable manner.[14]

Perceptual Functions — Considerable insight into perceptual abilities can be obtained by pencil and paper drawing tests. A five-year-old child should be able to copy a square, a six-year-old a triangle, seven- to eight-year-old a diamond. Older children can copy an octagon. Ability to trace a simple figure under a sheet of paper or trace a line between converging lines as described by Paine[15] assesses similar skills. Interpretation of pencil and paper copying tests requires experience and should usually be supplemented by formal psychometric testing. The ability to write from dictation develops between six and eight years of age. Use of this method to detect perceptual diffi-

culties is ordinarily useful only after this age group. Examination of handwriting patterns has been extensively used as a means for identifying children with dyslexia. It is a technique that is heavily dependent upon the experience and judgment of the examiner.

Differential Diagnosis

The detection of conditions that may produce or be associated with learning disorders in children is one of the prime responsibilities of the neurological consultant. Diagnostic approaches become clear when the physician has a clear notion of the differential diagnosis to be considered. The important syndromes to be considered are as follows:

Mental retardation
Cerebral palsy
Seizure disorders
Auditory disorders
Ocular disorders
Progressive neurological disorders

Mental Retardation

It is of the greatest importance to distinguish children whose learning difficulties are due to intrinsic limitations of intelligence from those who manifest specific learning problems. Many parents of children with mild but global retardation syndromes prefer to regard their children as possessing specific learning disabilities. Some retarded children are trained in verbal skills far beyond their actual abilities in judgment and performance.

A careful developmental history will often reveal evidence of delayed motor and speech development. Any child who was not walking unaided by 18 months of age is highly suspect of some major deficit in mental or neurological functions. Persistent inability to develop peer relationships is suggestive although by no means pathognomonic of mental retardation. Conversation with a child will often suggest to the physician the presence of dulness of mental faculties.

Whenever the presence of a mental retardation syndrome is suspected, use of one of the standard psychometric tests of intelligence is required. This is often the Wechsler Intelligence Scale for Children (WISC) which has the special virtue of being divided into verbal and performance sections. The Stanford-Binet is often utilized for younger children—6 years or under. These tests are not infallible indices of mental retardation, as performance on them may be affected by other factors; but no diagnosis of mental retardation should be considered without measuring the intelligence quotient. IQ's of 65 to 82 are generally considered in the educable range of mental retardation.

The physical examination of children with suspected mental retardation should include careful inspection of the skin for evidence of neurocutaneous syndromes. The presence of multiple *cafe-au-lait* spots, subcutaneous nodules or heavy freckling may suggest neurofibromatosis. Short stature and thickening of the neck folds in a girl should raise the issue of Turner's syndrome (45 chromosomes, XO karyotype). Buccal smear examination revealing a chromatin-negative pattern in a female will establish this diagnosis. Turner's syndrome is of special interest in learning disorders because of the recognition of a specific impairment of spatial abilities and of right-left directional sense in affected children.[16] It is this "space-form" deficit that may account for the high incidence of mild mental retardation in children with Turner's syndrome.

Other specific medical disorders to be considered in mild mental retardation are hypothyroidism, hypoparathyroidism, phenylketonuria and disorders affecting sex chromosomes. These conditions can be identified by appropriate laboratory procedures.

Cerebral Palsy

The term *cerebral palsy* refers to a group of disorders of motor function due to non-progressive brain lesions acquired in early life. It is common for children with overt cerebral palsy syndromes to manifest evidence of learning disorders. There are several reasons for this association. Many children with cerebral palsy have borderline intelligence levels. A motor handicap is a serious problem for a child attempting to adjust to the classroom routine. Hyperkinetic disorders present in these children may interfere with school adjustment. In addition to these obvious reasons for school failure, there is evidence of specific perceptual deficits in children with cerebral palsy.[17]

While overt forms of cerebral palsy are readily recognized, borderline forms present greater difficulties in diagnosis. It is important to remember that the manifestations of cerebral palsy may lessen or even disappear during later development. Thus it is not surprising that borderline manifestations of these syndromes may exist. It is important that these be recognized by the physician even if the relationship to the learning disorder is not clearly established at the time of examination. These may be categorized as "soft" neurological

signs by those not familiar with the various manifestations of mild CP syndromes.

Clumsiness. This expression generally refers to awkwardness of physical performance in activities involving gross muscle units—running, ball-playing, self-dressing, and the like. Walton and coworkers[18] described the "clumsy child syndrome" in children with learning difficulties who also manifested evidence of constructional apraxia, dysgraphia and dyscopia. Clumsiness is particularly prominent in ataxic forms of cerebral palsy. It is important to recognize the presence of ataxia in clumsy children. This symptom is due to a disturbance of postural fixation which, in children, is usually due to cerebellar fixation. This can be easily demonstrated by standard neurological tests of cerebellar function such as the finger-to-nose maneuver, pronation-supination of the forearm, touching each finger against the thumb in sequence, and ability to maintain hands in an outstretched position. Tandem walking (heel-to-toe) and ability to hop on one foot are especially sensitive tests of cerebellar functions.

Clumsiness is a highly nonspecific symptom that may be found in most mentally retarded children, may be associated with anxiety or may be present in children who are normal in all other respects. It is not appropriate to consider this symptom as indicative of some type of cerebral dysfunction unless definite supporting evidence of brain dysfunction is present such as hyperactive stretch reflexes, extensor plantar responses or definite ataxia.

Involuntary movements. Some children with learning problems are restless and fidgety much of the time. They may manifest choreic-like adventitious movements that may be elicited by asking the child to extend his arms or place them on his knees for a moment or two. Environmentally induced stress will often bring out these movements. Sometimes voluntary activity results in "overflow" phenomena—that is, the occurrence of unwanted movements in addition to the desired movements. Mirror movements refer to overflow into the opposite side of the body and may be particularly prominent in hemiparesis with overflow into the normal side. Involuntary movement disorders due to brain lesions must be distinguished from tics of psychogenic origin. The latter are stereotyped muscle twitches usually involving the same muscle groups that are characteristically seen in the facial and ocular muscles.

Gait disturbances. Observations of gait and posture will uncover mild forms of cerebral palsy when gross abnormalities are not evident. Walking is a complex neuromotor task involving many reflex and integrative functions. Toe walking, hemiplegic gaits (circumduction of leg and diminished swinging of arm), wide-based gaits and difficulty with tandem walking may be manifestations of cerebral palsy syndromes. Observation should be made of walking, running, ability to rapidly reverse direction, and tandem walking. The condition of the soles of the shoes should be inspected for evidence of asymmetric wear. The different gait abnormalities found in cerebral palsy syndromes are described in detail by Paine and Oppe.[9]

Seizure Disorders

As in cerebral palsy, there are several reasons why children with seizures may do poor work in school. The occurrence of frequent seizures tends to interfere with mental processes. Hyperkinetic behavior is common in children with recurrent seizures. The administration of high doses of anticonvulsant agents may in itself interfere with cognitive functions. The existence of learning problems is likely to be ignored in epileptic children whose seizures are difficult to control, even though the school problems may be more disruptive to the child than the seizures.

An important responsibility of the physician examining children with learning disorders is the detection of unrecognized seizure phenomena. The hallmark of seizure phenomena is abrupt alteration of behavior. Temporal lobe seizures may manifest themselves as behavioral automatisms such as lip-smacking, chewing movements or abrupt disorientations. The child may appear confused, drowsy or upset afterward. There are some reports of prolonged behavior disturbances representing seizures,[20] but this is a rare event.

When a seizure disorder is suspected, obtaining an electroencephalogram will commonly although not invariably reveal evidence of epileptiform discharges. This means that paroxysmal hypersynchronous discharges, generalized or focal, are seen in the tracing. Mild dysrhythmic disturbances in the electroencephalograms of children have little clinical significance at present.

The occurrence of major EEG abnormalities such as polyspike or spike and wave discharges can be found in 5 to 10 percent of children with learning disorders in the absence of overt clinical manifestations of seizures.[21,22] Paine[23] suggested that this phenomenon represents a borderline form of epilepsy. The effect of subclinical EEG seizure

bursts upon the learning process is not understood at present but it would be surprising if some relationship did not exist.

Auditory Disorders

Hearing deficits may produce classroom impairment in the absence of gross deafness. These are usually due to high-frequency hearing loss as indicated by a sloping configuration of the audiogram.[24] High-frequency deficits result in loss of consonant recognition that is functionally more disabling than low-frequency losses. Severe high-frequency losses are always associated with some degree of speech impairment. Less severe deficits may not noticeably affect speech but may require intensive concentration by the child in order to hear. Such children may seem to lose interest in classroom activities or be accused of uncooperative behavior when in fact they cannot maintain the effort required to hear the teacher.

Screening audiometry should be performed on all children with unexplained learning problems. This is a simple office procedure that can be carried out by a nurse or assistant. Any evidence of a deficit indicates the need for full-scale audiologic evaluation. Failure to recognize hearing deficits in children with school problems will result in expenditure of much misdirected effort with little to show for it. It is surprising how long high-frequency hearing deficits in children may go undetected.

Ocular Disorders

There is a consensus among ophthalmologists who have looked into the relationship of ocular disorders to reading problems that minor disturbances of visual acuity or ocular muscle imbalance do not themselves produce reading problems although they may aggravate an existing situation.[25] Many claims have been made relating poor ocular skills, eye-hand coordination problems or constricted visual fields to learning problems, but there is little evidence that ocular training programs in themselves are of value in assisting children to learn. Intermittent squints and refractive errors are equally common in children with and without reading problems.[26]

The above statements do not mean that evidence of squint, eye-strain or poor visual acuity does not call for appropriate treatment. It should not be expected, however, that these measures will prevent or reverse reading disorders in children except in very rare cases.

Progressive Neurological Disorders

Progressive neurological disorders are rare but their detection should not be missed by the consulting physician. There are a number of degenerative neurological disorders whose onset may be heralded by learning problems during childhood. The gradual worsening of symptoms, such as emotional lability, movement disorders or coordination problems in a child without obvious environmental difficulties suggests a central nervous system degenerative disorder. These include Huntington's chorea, Wilson's disease, subacute sclerosing panencephalitis and juvenile cerebromacular degeneration.[1] Family and genetic counseling are of great importance in these disorders.

Brain tumors in the cerebral hemispheres may produce subtle signs of personality disturbances for years before the true nature of the problem is recognized (often by onset of a seizure). Intractable headache is a common associated complaint. The behavior of children with brain tumors is often characterized by apathy and a tendency to withdrawal. Electroencephalograms, skull radiographs and radioisotope brain scans are procedures that should be performed at once if brain tumor is suspected.

Learning Disorder Syndromes

Developmental Hyperactivity, Minimal Brain Dysfunctions, Specific Learning Disabilities, Perceptual Deficits, Developmental Dyslexia

When the physician has completed the neurological examination and has disposed of the issues listed under Differential Diagnosis, the nature of the problem from a medical viewpoint becomes highly uncertain. A welter of psychometric data, family disturbances, educational theories, drug programs and "neurological" theories will confuse the most conscientious physician in the assessment of children with learning difficulties who do not have identifiable somatic problems. There is little agreement about the origin of learning difficulties that affect a substantial number of school-age children. A discussion of these issues will usually reflect the particular frame of reference of the discussant. Nevertheless, it is possible to make a number of statements about minimal brain dysfunction and related terms that may fairly represent the current situation:

- The acquisition of visual or auditory percep-

tual skills is determined by the interaction of genetic, cultural and familial factors that determine maturation in this field much as they determine maturation of motor, speech and social skills. The statement that a child has a "perceptual deficit" as determined by performance on highly structured psychometric tasks is essentially a restatement of the fact that a child is having learning difficulties. It tells little of the origin or nature of the deficit. It is essential to remember that many factors may affect a child's performance on psychological tests. Chief among these are inadequate motivation, emotional conflicts and limitations stemming from disadvantaged environments. The presence of evidence of perceptual deficits cannot be automatically attributed to cerebral dysfunction.

There is growing evidence that many children labelled as handicapped by perceptual disturbances really have a deficit of attentional abilities.[27] Other investigators have emphasized poor teaching practices as the basic problem when children of normal intelligence fail to learn at school. Socioeconomic and family factors play a significant role in determining achievement in the classroom. The term *specific learning disability* is a useful expression without etiological implications that can be used to categorize children with learning disorders who do not manifest any of the previously discussed illnesses.

- Hyperactive behavior (short attention span, distractibility, impulsivity are essentially equivalent terms) is a sign of behavioral disturbance that may be associated with a wide spectrum of syndromes. Mental retardation, brain damage syndromes, seizure disorders, primary behavior problems, overly restrictive environments, dysfunctional families, childhood autism and neurological degenerative disorders are all conditions that may result in hyperactive behaviors. The presence of this behavioral syndrome should alert the physician to carefully evaluate the child and his environment for the presence of these factors. Some children, otherwise quite normal or even precocious in development, manifest high activity levels as part of their temperamental characteristics. The term *developmental hyperactivity* has been applied to these children.[28]

- Most investigators who have studied the family status of children with learning disorders have recognized the prevalence of disturbed and dysfunctional families. This approach is not popular among educators at present but seems apparent to clinicians who see these children and their families.

- The presence of questionable, borderline or mild EEG abnormalities in children is not a reliable guide to the presence of cerebral dysfunction in children. Slow wave patterns in posterior regions, sporadic sharp waves, 14 and 6 cycle per second positive spikes and other EEG variants are common in normal children. Emerging information about the EEG in highly selected normal children[29] is providing new information about the wide range of normal variation in the EEG's of children.

- *Minimal brain dysfunction* as a nosological entity remains a poorly defined concept at present. It is essentially a diagnosis of exclusion in children with learning and behavioral problems after gross neurological, psychiatric and social causes of learning problems have been ruled out. Soft neurological signs are highly nonspecific findings that are affected by the same factors as those previously mentioned in discussing perceptual deficits. Attentional difficulties, memory difficulties, laterality disturbances, overflow movements, minor reflex asymmetries and other "subtle" signs of cerebral dysfunction are usually due to maturational lags, psychological stresses or both of these factors interacting. Macdonald Critchley's[30] concept of the dyslexic child as a "late bloomer" is more to the point in explaining the nature of many learning problems in children than is the notion of a cerebral dysfunction.

- The high incidence of learning disorders in boys remains an enigmatic phenomenon. Virtually all series analyzed reveal a striking male preponderance up to five to one. The peculiar predilection of boys to manifest learning problems has been attributed to various factors[31] but no really satisfactory explanation is available. The slower tempo pace of maturation in boys, the greater social expectation for achievement, an innate male aggressivity with poor impulse control, feminine dominance in grade-school and maternal difficulties with assertive behavior in their sons all have been considered. Perhaps each plays a role in specific cases.

- The tactics and strategy of managing a child with a learning disorder are more appropriately the task of a family-oriented physician than a neurological consultant. Perhaps this view might be restated that, insofar as the neurological consultant wishes to assist the child with a learning disorder beyond clarification of specific neurological issues, he must develop the attitudes of a

TABLE 1.—*Principles of Management of Learning Disorders*

1. Communicating a Diagnosis with Explanation of Terms—For Example, Hyperactivity, Specific Learning Disability, Dyslexia, Delayed Language Maturation, Minimal Brain Dysfunction.
2. Parent Counseling. Reordering environment of hyperactive children, consistency of routines, consideration of adverse family factors. Referral for psychological therapies such as behavior modification for the child or family therapy for parents.
3. Education Therapy. Use of individual tutors, special classes or special schools.
4. Drug Therapy. Use of Cerebral Stimulants (methylphenidate or amphetamines) in "hyperactive children." Avoidance of barbiturates or related drugs.
5. Continuous supervision for evaluation of success or failure of treatment programs.

physician aware of family and community processes. This will lead him far afield from neurological diagnosis but he will be fortified by recollecting that helping the patient in all aspects of his life is the oldest tradition of Hippocratic medicine. Furthermore, the neurological consultant is in a better position than other physicians or professional workers to integrate the various strands leading to a learning disorder and to guide the parents in evolving a sensible and unbiased approach toward the problem.

The purpose of this review is not a detailed discussion of the role of the physician in the management of children with learning disorders. However, it may be appropriate to indieate general categories of management approaches. These are summarized in Table 1. Further consideration of management issues can be found elsewhere.[1]

Conclusion

The prevalence of children with learning disorders in our society means that physicians who treat children must develop a point of view and a working procedure for assisting children brought to them with the principal complaint of difficulties in school. An approach to this problem can be divided into two parts: (1) detection of specific neurological or sensory disorders and (2) comprehensive management of school problems. The detection of neurological disorders relies upon conventional medical knowledge for recognition and treatment of disease states that may have produced or significantly contributed to the school problem. Comprehensive management requires a broader approach by the physician, including parent counseling, advice about educational issues and consideration of drug therapy. In all instances, parents should be able to rely on the physician to act as a scientific resource for guidance as to merits of various kinds of therapy directed toward children with learning disorders. The ability to function effectively in this manner will enable the physician to provide a service to children and their families that may profoundly affect their lives.

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